THERMAL INJURY IN THE PREGNANT PATIENT

Brian W. Amy, M.D., William F. McManus, M.D., F.A.C.S., Cleon W. Goodwin, M.D., F.A.C.S., Arthur Mason, Jr., M.D., *and* Basil A. Pruitt, Jr., M.D., F.A.C.S., *Fort Sam Houston, Texas*

MOST reports of pregnant patients with thermal injuries have been descriptions of isolated instances or combined reviews from several large centers (1–7). Our experience with 30 consecutively treated pregnant patients with burns over a period of 33 years, 1950 through 1982, is presented herein. Nineteen previously reported instances are also presented (8). Since resuscitation, initial care, burn management and obstetric support may vary from institution to institution, the present study describes a series of patients who were managed at a single burn center and varied only with respect to our evolving knowledge of burn management. The introduction of aminoglycosides, topical chemotherapy and critical care support have all added to the effectiveness of care of the burned patient.

MATERIAL AND METHODS

Since 1950, 6,573 patients have been admitted to the Institute of Surgical Research, 1,157 (17.6 per cent) were female of whom only 448 (6.8 per cent) constituted a potentially fertile population of reproductive age (15 to 45 years). In this latter group, 30 patients (6.7 per cent) were pregnant at the time of injury. Gestational age ranged from five to 36 weeks, with ten in the first trimester, 14 in the second trimester and six in the third trimester. The cause of thermal injuries is summarized in Table I.

Patients admitted directly to the Institute of Surgical Research were resuscitated according to the Brooke formula or the modified Brooke formula (9). Minor deviations from these standard regimens may have occurred if the patient had been treated initially at a referring hospital or by another regimen in those years prior to the development and widespread use of the aforementioned formulas.

Antibiotic prophylaxis was not used. All patients were given tetanus prophylaxis if immunization was incomplete. Upon admission, burn areas were debrided, cleansed with a standard surgical detergent and treated in general by the exposure method. Topical mafenide acetate was used after 1964 and silver sulfadiazine was introduced in 1974. Bronchoscopy was accomplished if inhalation injuries were suspected.

In general, burns were allowed to mature and demarcate for seven to 21 days prior to excision and autografting. Obstetric consultation was obtained on all mothers with burns of greater than 20 per cent of the total body surface. Probable individual mortality, based upon age and burn size, was estimated from logistic analysis of mortality experience in the population of patients admitted to this institute in recent years. Probable total mortality was estimated from the individual values by the method of Flora (10).

RESULTS

Resuscitation was successful in all 30 patients and no patient died earlier than postburn day eight. The patient data and outcome for the 30 pregnant women with thermal injuries are summarized in Table I. Also, probability of individual maternal mortality based upon a logistic analysis of patient outcome at the institute is reflected in the last column of Table I. Maternal mortality in this group of 30 patients, based upon burn size and age, was predicted to be 10.2 deaths, with a 95 per cent confidence interval of 6.97 to 13.45, and ten deaths were observed. The patients were divided into three groups: 1, total body surface of less than 20 per cent; group 2, total body surface of 20 to 50 per cent, and group 3, total body surface of greater than 50 per cent. Maternal and fetal survival are summarized in Table II. Of the 30 patients who were pregnant, there were 20 maternal survivors and 17 fetal survivors.

From the United States Army Institute of Surgical Research, Brooke Army Medical Center, Fort Sam Houston.

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TABLE I.—PATIENT DATA AND OUTCOME

Patient No.	Age, yrs.	Weeks gestation	Extent of burn, —per cent— Total	Third degree	Cause of burn	Fetal survival	Maternal survival	Maternal complications	Probability of maternal mortality
1*	22	20	6.0	0	Apartment fire	+	+	None	0.003
2	23	24	6.0	6.0	Motor vehicle accident	+	+	None	0.003
3	21	36	6.0	0	Gasoline fire	+	+	None	0.003
4*	22	26	8.5	0	Gas heater explosion	+	+	None	0.004
5*	24	26	12.0	10.0	Clothes ignited by heater	+	+	None	0.008
6*	30	19	15.0	0	Oil stove explosion	+	+	None	0.013
7	17	22	15.0	0	Trailer fire	+	+	None	0.016
8	20	27	21.0	15.0	Gasoline fire	+	+	None	0.030
9*	37	29	24.5	8.5	Clothes ignited	−	+	Burn wound cellulitis	0.052
10	18	12	24.5	10.0	Gasoline stove explosion	−	+	Inhalation injury; septicemia	0.052
11*	22	15	26.0	12.0	Clothes ignited by heater	+	+	None	0.054
12*	18	5	28.5	4.5	Clothes ignited by stove	+	+	Suppurative thrombophlebitis	0.082
13*	21	36	29.5	3.0	Cleaning fluid fire	+	+	None	0.086
14*	15	8	30.0	28.0	Kerosene fire	+	+	Pleural effusion	0.099
15*	15	28	31.0	10.5	Fire bomb	+	+	None	0.106
16	32	8	31.5	12.0	Gas stove explosion	+	+	Gastrointestinal bleeding	0.196
17*	36	15	39.5	6.0	Kerosene	+	+	None	0.253
18	20	22	41.5	6.0	Gasoline explosion	−	+	Respiratory distress; prolapsed umbilical cord	0.254
19*	19	10	43.0	20.0	Clothes ignited by heater	+	+	None	0.276
20	17	36	45.0	24.0	Gasoline explosion	−	+	Fetal distress during resuscitation	0.326
21	23	22	57.5	13.0	Gas explosion	−	−	Inhalation injury, staphylococcus, septicemia, pneumonia	0.599
22	16	25	56.5	24.5	Clothes ignited by heater	−	−	Sepsis, acute renal failure, adult respiratory distress syndrome	0.603
23*	29	15	60.5	26.5	Kerosene fire	−	−	Septicemia, burn wound sepsis, pneumonia	0.671
24*	18	35	68.0	42.0	Gasoline explosion	+	−	Dilution hyponatremia	0.808
25*	20	25	73.0	58.2	Aircraft accident	−	−	Dilution hyponatremia, septicemia pneumonia	0.873
26	18	13	73.0	58.0	Clothes ignited by fireplace	−	−	Inhalation injury, disseminated intravascular coagulation, septicemia, renal failure	0.877
27*	37	26	74.5	24.0	Church fire	−	−	Bronchopneumonia	0.918
28*	16	22	86.0	40.0	Gas heater explosion	−	−	Bronchopneumonia, septicemia	0.974
29*	26	16	90.0	35.0	Propane tank explosion	−	−	Anuria, dilution hyponatremia	0.983
30*	27	25	92.0	85.5	Gasoline fire	−	−	Anuria, vaginal bleeding	0.987

*From the study done by Taylor and co-workers (8) in 1976.

No maternal deaths occurred in group 1, which consisted of seven patients; all fetuses were carried successfully in utero by the injured mother during the postburn period and were alive at the time of discharge. In group 2, all 13 patients survived but only nine (70 per cent) of the fetuses survived; eight fetuses were successfully carried in utero through the recovery of the mother and discharge, and five women delivered prematurely during their hospital courses. Only one of these spontaneous deliveries occurred on the first postburn day and resulted in a viable fetus, which was 36 weeks gestational age and weighed 2,259 grams. The other four spontaneous deliveries in this group (Patients 9, 10, 18 and 20) resulted in the death of the fetus as early as the second postburn day and coincided with maternal complications of infection, hypotension or hypoxemia.

All ten gravid females in group 3 died and only one fetus survived. Delivery of a fetus at 36 weeks gestational age and weighing 2,500 grams by a woman with a 68 per cent total body surface burn occurred on postburn day eight. This event was preceded on postburn day seven by hyponatremia (plasma sodium concentration equals 123 milliequivalants per liter) due to overhydration during and immediately after the resuscitation period.

Delivery occurred 49 days prior to the eventual death of the mother. Of the remaining fetuses, nine aborted spontaneously prior to the death of the mother, but were in either the first or the second trimester in gestational age and were nonviable upon delivery. Two of these abortions occurred before the end of the third postburn day.

DISCUSSION

Maternal survival was influenced by the extent of injury. In a statistical comparison of the mortality of 30 pregnant patients with that of comparable burned nonpregnant female patients admitted to our center, pregnancy, per se, did not appear to influence survival of the gravid female.

Since all fetuses were viable upon admission and 15 (50 per cent) were successfully carried in utero through the hospital course, obstetric support should be obtained for all pregnant patients with thermal injuries, especially when the total body surface area is greater than 20 per cent. As expected, fetal survival after moderately severe injury was strongly influenced by the development of significant maternal complications. In patients 9 and 10 in whom survival was likely but the fetus died, there were maternal complications of burn wound infection in patient 9 and hypoxemia and sepsis in patient 10. Each of these complications occurred prior to the spontaneous delivery. Patients 18 and 20 had larger burns and in each instance maternal complications, hypoxemia or hypotension, respectively, occurred prior to the abortion. If gestational age is sufficient for the fetus to survive, obstetric intervention may be considered at the onset of an extensive medical complication even if it is likely that the mother will survive the insult, the already stressed fetus may not.

Fetal survival was also prejudiced by the extent of burn injury of the mother. With maternal burns comparable in size to those in group 3, aggressive fetal monitoring should be considered since there were no maternal survivors, nine fetuses were spontaneously aborted prior to the death of the mother and the only fetal survivor was near term upon delivery.

Maternal hypoxemia associated with inhalation injury, as well as any episode of respiratory distress or pneumonia, may be particularly injurious to the fetus. Hypoxemia decreases placental blood flow and impedes oxygen delivery across the uteroplacental interface (11, 12). Additionally, it has been pointed out that exposure to carbon monoxide during the prenatal period may affect cardiac development and may produce fetal cardiac edema (13).

The results of studies on animals indicate that the fetus may tolerate the early stages of maternal sepsis, but the fetus is markedly affected during the later stages, as the mother decompensates and her cardiovascular system collapses (14). When present in our series, sepsis resulted in death of the fetus.

TABLE II.—MATERNAL AND FETAL SURVIVAL

Groups	*TBSA, per cent*	*No. of patients*	*Maternal survival*	*Fetal survival*
1	0–10	4	4	4
	11–20	3	3	3
2	21–30	6	6	4
	31–40	4	4	4
	41–50	3	3	1
3	>50	10	0	1
Total		30	20	17

TBSA, Total body surface area.

The gravid female has a changing cardiovascular profile due to the enlarging placenta and fetus. Blood volume, cardiac output and uterine blood flow increase as the fetus develops. The goal of resuscitation of the burn patient is to maintain adequate vital signs and organ perfusion. This is compatible with our clinical finding that maternal hypotension due to inadequate fluid resuscitation or any other cause was a contributory factor in the death of the fetus. This point underscores the need for aggressive fetal monitoring during maternal resuscitation and it should be pointed out that while all m ers survived initial resuscitation, 13 per cent of the fetuses, three nonviable fetuses and one viable term fetus, were spontaneously aborted during the first 96 hours after injury. Even careful monitoring, hemodynamic stability and successful resuscitation of the gravid female does not insure fetal survival during this initial period.

SUMMARY

Thermal injury sustained during pregnancy presents special management problems for both the gravid woman and her unborn child. Of 6,573 admissions to this burn center during the period of 1950 through 1982, 1,157 (17.6 per cent) were female and 448 (6.8 per cent) were of reproductive age. Thirty of this latter group (6.7 per cent) of burned patients were pregnant at the time of injury. These 30 patients ranged in age from 16 to 37 years old (an average of 22.7 years) and the burned portion of the total body surface area ranged from 6 to 92 per cent (an average of 39.7 per cent). A review of the clinical courses of these 30 patients suggests several observations and conclusions. Pregnancy does not alter the maternal outcome after thermal injury and maternal survival is usually accompained by fetal survival in the absence of significant complications. If the injury of the gravid patient is lethal, the pregnancy will usually terminate spontaneously prior to her death. Obstetric support and aggressive fe-

tal monitoring is recommended for all moderately and severely burned pregnant patients. Obstetric intervention may be considered in the ill patient with a near term fetus in whom significant complications (such as, hypotension, hypoxemia or sepsis) jeopardize the life of the fetus.

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